Item 9. Groundwater Quality Data

Reason that accurate data and analyses are needed: Flow paths beneath Red Hill facility are poorly understood. Analysis of groundwater chemistry can help constrain flow paths. The groundwater flow model will underpin the transport model (developed to predict the fate of contaminants from a release) which should present reasonable correspondence with available water quality data. This includes contaminant data and other data that may evidence groundwater impacts (e.g., terminal electron acceptors [TEAs]) or of migration directions and mixing of waters from different sources (e.g., isotopic data or other quality indicators). Before developing the transport model, it is important that the CSM encompass reasonable interpretations of available water quality data.

Problem encountered: The interpretation of groundwater quality data presented in interim TUA documents is in places non-conservative, and conflicts with other lines of evidence and with conclusions reached by regulator SMEs. Example 1: the Navy consultants dismiss some detected results out of concerns for data quality. Even if justified, this does not address *all* detected results, and from the regulator perspective, if *any* of the reported detects are real this is evidence impacts occurred. Example 2: TEA data (Inset Figure 9.1) as indications of natural attenuation, dissolved phase contaminant detection frequency and distribution (inset Figure 9.2), and hydraulic gradients, all suggest transport occurred not just to the southwest but also to the northeast of the facility. Example 3: the distribution and concentrations of general chemistry data (i.e. major ions, specific conductivity, and pH) show a poorly-mixed system inconsistent with the Navy CSM of robust flow from upslope recharge areas to Red Hill Shaft. The chemistry is highly variable with chloride concentrations spanning over an order of magnitude and is more suggestive of sluggish down-slope flow and compartmentalization (inset Figures 9.3 and 9.4).

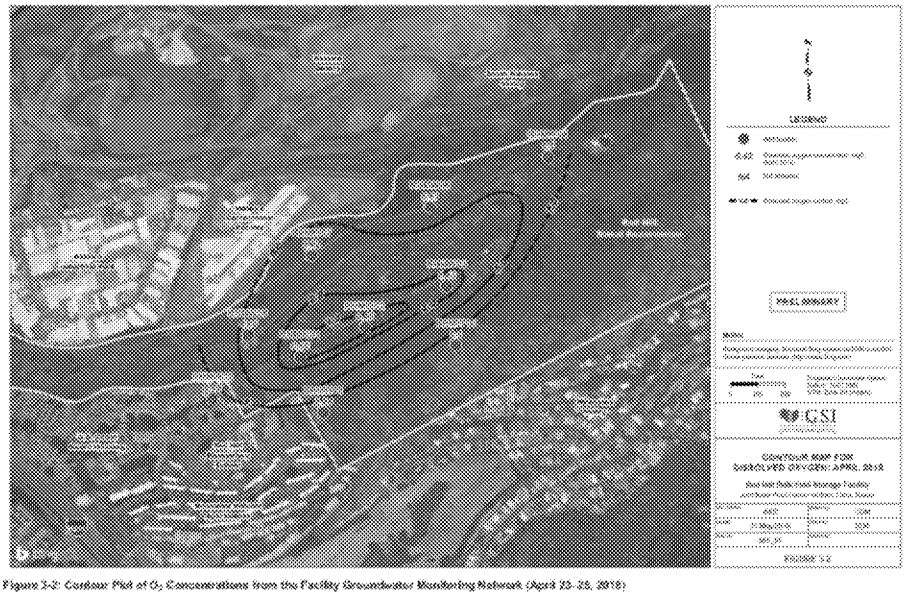

Figure 9.1 Example Terminal Electron Acceptor (TEA) Map – Dissolved Oxygen

The relative absence of high-concentration detections within the small, widely-spaced, monitoring network around Red Hill is not proof of absence of impacts, but appears to be interpreted as such by the Navy consultants. Other data, including TEAs, TPH and individual fuel constituents suggest a broad area of groundwater impacts that extends in various directions, a complex groundwater flow system that is not uniformly Mauka-to-Makai, and the possibility of LNAPL impacts at the water table as the cause.

The final CSM should at this stage allow for "alternative hypotheses" of at least equivalent likelihood of LNAPL impact to groundwater versus the current hypothesis of there having been no impact. The final groundwater flow model, when it reasonably represents hydraulic gradient directions and magnitudes in the vicinity of Red Hill ridge, would be anticipated to underpin a contaminant transport model that demonstrates a reasonable match historical sample results (contaminants and TEAs, etc.), thereby demonstrating that the model is useful for near-field transport to understand the available groundwater data, and for developing predictions of contaminant transport and fate to help evaluate risk and mitigating responses or strategies.

Figure 9.2 Example Map of TPH-D Detections

Figure 9.3 Image of Chloride Concentrations Sampled at Wells

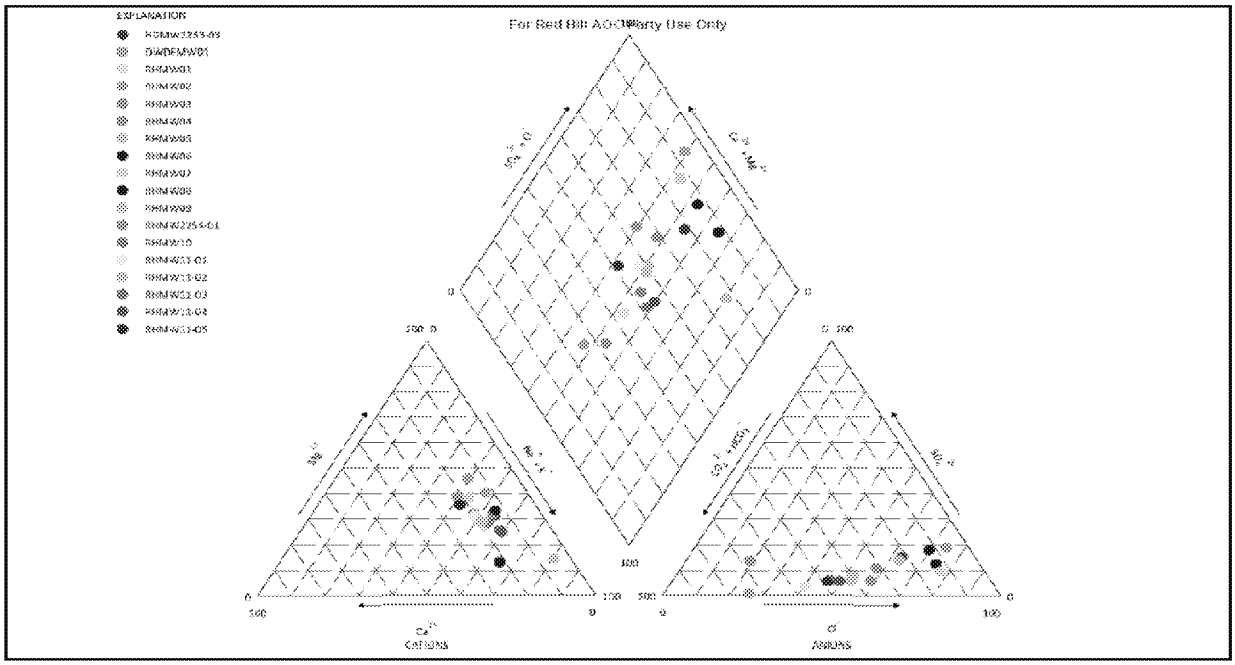

Figure 9.4 Example Piper Diagram